PATENT SPECIFICATION (11) 1 516 224

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(21) Application No. 4219/76 (22) Filed 3 Feb. 1976
(31) Convention Application No. 547 410
(32) Filed 6 Feb. 1975 in
(33) United States of America (US)
(44) Complete Specification published 28 June 1978
(51) INT CL² F16K 11/10
(52) Index at acceptance F2V D1 D4X L6D

(19)

(54) FLUID CONTROL VALVES

(71) We, COMMERCIAL SHEARING INC., a corporation of Ohio, of 1775, Logan Avenue, Youngstown, Ohio, 44501, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to pressure compensated work port fluid valves and to work port compensators and particularly to a work port pressure compensator valve which may be combined with the outlet port of a conventional directional control valve to provide pressure compensation to the valve combination.

Pressure compensation of directional control valves is not new and has been provided in a variety of forms and configurations. Heretofore, however, pressure compensation has primarily been carried out by providing a special inlet section coupled with a modified form of directional control valve configuration. Typical of such prior art valve combinations are those illustrated in U.S. Patent Specifications 3,565,110, 3,602,104, 3,602,243, 3,255,777 and 3,234,957. All of these structures are designed to supply a constant volume of fluid, however, none of these structures can be adapted to standard closed centre of open centre directional control valves.

In accordance with the present invention there is provided a work port pressure compensator valve adapted to be removably attached to a directional control valve having an inlet chamber, a work chamber and an outlet chamber, the compensator comprising a housing having a compensator inlet chamber for connection to the work chamber of the directional control valve, a compensator outlet chamber spaced from said compensator inlet chamber, a work port connected to said compensator outlet chamber, a bore connecting said compensator inlet and outlet chambers, a compensator valve member movable in said bore and having an annular groove intermediate its ends, resilient biasing means urging said compensator valve member toward the compensator inlet chamber to a first position in which the compensator inlet chamber and compensator outlet chamber are in communication through the annular groove, a first signal passage connecting the compensator inlet chamber to the bore whereby fluid pressure in the compensator inlet chamber acts on one end of the compensator valve member to urge the compensator valve member toward said first position, and a second signal passage for connection with a passageway connected to the inlet chamber of the directional control valve the second signal passage being connected to said bore at the other end of the compensator valve member whereby, when the compensator valve is attached to the directional control valve pressure fluid in the inlet chamber of the directional control valve will act on the end of the compensator valve member to urge the compensator valve member toward the compensator outlet chamber to reduce the flow of fluid through the groove in the compensator valve member whereby said compensator valve member will be moved in the bore in response to pressure differential between the inlet chamber of the directional control valve and the compensator inlet chamber to maintain a substantially constant pressure at the compensator work port.

The invention also provides a pressure compensated work port fluid valve comprising a directional control valve having a housing with inlet and outlet ports, a bore extending through said housing, a valve member movable in said bore, an inlet chamber intersecting said bore and connected to the inlet port, a work chamber spaced from said inlet chamber, an outlet chamber intersecting said bore, said work chamber being adapted to be connected to said inlet chamber in one position of the valve member and to the outlet chamber in a second position of said valve member, a second bore in said housing, a second inlet

chamber intersecting said second bore and connected to said work chamber, a second outlet chamber intersecting said second bore and spaced from said second inlet chamber, a work port connected to said second outlet chamber, a second valve member having an intermediate annular groove which is movable in said second bore, resilient bias means urging said second valve member toward the second inlet chamber into a first position in which the second inlet chamber and second outlet chamber are in communication through the annular groove in the second valve member, a first signal passage connecting the second inlet chamber directly to the second bore at one end of the second valve member whereby pressure fluid in the second inlet chamber urges the second valve member into said first position and a second signal passage connecting the first inlet chamber directly to said second bore at the other end of the second valve member whereby pressure fluid in the first inlet chamber acts on the second valve member to urge the second valve member toward the second outlet chamber to reduce the flow of fluid through the groove in the second valve member, whereby the second valve member is moved in the second bore in response to pressure differential between the first inlet chamber and the second inlet chamber to maintain a substantially constant pressure at the work port.

Some preferred embodiments of the invention are described in detail below, by way of example with reference to the accompanying drawings, in which:—

Figure 1 is a sectional view of a compensator embodying the invention combined with a closed centre valve of conventional configuration;

Figure 2 is a sectional view through a second embodiment of compensator valve according to this invention; and

Figure 3 is a sectional view through a third embodiment of compensator valve according to this invention.

Referring to the drawings, there is shown a known closed centre valve having a valve body 10 with a bore 11 carrying a valve member 12. Work chambers 13 and 14 intersect bore 11 at opposite ends of the housing and communicate with work ports 15 and 16. Parallel high pressure chambers 17 and 18 intersect the bore 11 and communicate with a source of high pressure fluid. Outlet chamber 19, 19a also intersect the bore 11. Compensator housing 20 is fixed to housing 10 by bolts (not shown). Compensator housing 20 has an inlet chamber 21 communicating with work port 15 and a spaced outlet chamber 22 communicating with a threaded work port 23. A bore 24 extends through both chambers 21 and 22 and carries valve member 25 slidable therein. Valve member 25 is biased toward inlet chamber 21 by spring 26. An annular groove 27 is provided in valve member 25. A first signal passage 28 in housing 20 connects inlet chamber 21 with bore 24 at the end carrying spring 26. A second signal passage 29 connects high pressure chamber 17 to the end of bore 24 so that the pressure in chamber 17 is applied to the end of valve member 25.

The operation of the valve structure described above is as follows: The control valve member 12 is shown in Figure 1 in the neutral position. When member 12 is shifted to the right, high pressure fluid in passage 17 flows through radial passage 12*a*, axial bore 12*b* through check valve 12*c* and out radial passage 12*d* into work chamber 13 from which it enters inlet chamber 21. At this point a pressure drop will exist between chamber 21 and chamber 17. This is sensed by the valve member 25 which moves in response to the pressure differential between the spring bias 26 combined with fluid pressure from first signal passage 28 and the pressure on the end of valve member 25 created by fluid pressure from second signal passage 29. When the pressure in passage 29 is great enough to overcome the combined spring and inlet pressure bias, the valve member 25 will shift to the left (viewing Figure 1) and will restrict the flow of fluid, thereby maintaining the pressure in the whole valve structure. If the member 12 is shifted to the left as seen in Figure 1 the work chamber 13 communicates with the outlet chamber 19 through radial passage 12*a*, axial bore 12*b*, check valve 12*c* and radial passage 12*d*.

In addition, there is shown in Figure 1 an anti-cavitation valve feature which is formed by bore 30 in housing 20 parallel to bore 24 and also extending through both chambers 21 and 22. A floating ball 31 is provided within an enlarged chamber portion 32 of bore 30. This ball is normally held by pressure in chamber 21 against the end of bore 30 to prevent flow of fluid through bore 30, however, in the event of a pressure drop in chamber 21, the ball will open and fluid flow directly from the outlet chamber to the inlet chamber through bore 30. Alternatively, the ball 31 could be spring loaded to provide a relief check valve.

In Figure 2 there is illustrated a modification of this valve used on both work ports. The valve of Figure 2 is essentially the same as that of Figure 1 except for configuration of the parts and accordingly like parts have been given like numbers with a prime suffix. One major difference here is that bore 24' is extended through the full length of housing 20' and is blocked inter-

mediate its ends by a plug 40' which may be held in place by a pin 41' or by some other means. In operation, each compensator portion operates precisely as described above in connection with Figure 1.

In Figure 3 there is illustrated a second modification of the invention in which a compensator housing 50 has an inlet chamber 51 communicating with work port 15 of a closed centre valve such as shown in Figure 1 and a spaced outlet chamber 52 communicating with a threaded work port 53. A bore 54 extends through both chambers 51 and 52 and carries valve member 55 slidable therein. Valve member 55 is biased toward inlet chamber 51 by spring 56. An annular groove 57 is provided in valve member 55 intermediate its ends. A first signal passage 58 connects inlet chamber 51 with bore 54 at the end carrying spring 56. A second signal passage 59 connects high pressure chamber 17 to the end of bore 54 so that pressure in chamber 17 is applied to the end of valve member 55. Valve member 55 is provided with an axial bore 60 which communicates with the exterior of the valve member at the ends of annular groove 57 through radial passages 61 and 62. An enlarged bore 63 at the end of bore 60 carries a check valve 64, biased to closed position by spring 65. Radial passages 66 communicate from bore 63 through the walls of the valve member.

The operation of the valve of Figure 3 is essentially the same as that of Figure 1. The principal difference is in the fact that instead of a separate bore carrying a relief check valve, the relief check valve 64 is built into valve member 55. As in the case of Figure 1, a floating ball could be substituted for relief check valve 64 to provide an anti-cavitation function as there described.

WHAT WE CLAIM IS:—

1. A pressure compensated work port fluid valve comprising a directional control valve having a housing with inlet and outlet ports, a bore extending through said housing, a valve member movable in said bore, an inlet chamber intersecting said bore and connected to the inlet port, a work chamber spaced from said inlet chamber, an outlet chamber intersecting said bore, said work chamber being adapted to be connected to said inlet chamber in one position of the valve member and to the outlet chamber in a second position of said valve member, a second bore in said housing, a second inlet chamber intersecting said second bore and connected to said work chamber, a second outlet chamber intersecting said second bore and spaced from said second inlet chamber, a work port connected to said second outlet chamber, a second valve member having an intermediate annular groove which is movable in said second bore, resilient bias means urging said second valve member toward the second inlet chamber into a first position in which the second inlet chamber and second outlet chamber are in communication through the annular groove in the second valve member, a first signal passage connecting the second inlet chamber directly to the second bore at one end of the second valve member whereby pressure fluid in the second inlet chamber urges the second valve member into said first position and a second signal passage connecting the first inlet chamber directly to said second bore at the other end of the second valve member whereby pressure fluid in the first inlet chamber acts on the second valve member to urge the second valve member toward the second outlet chamber to reduce the flow of fluid through the groove in the second valve member, whereby the second valve member is moved in the second bore in response to pressure differential between the first inlet chamber and the second inlet chamber to maintain a substantially constant pressure at the work port.

2. A valve as claimed in claim 1 having anti-cavitation valve means connecting said second inlet and second outlet chambers.

3. A valve as claimed in claim 2 wherein the anti-cavitation valve means comprises a third bore connecting said second inlet and second outlet chambers and valve means in said bore movable in response to pressure differential between said chambers to permit flow from the second outlet to the second inlet chamber when the pressure in the second inlet chamber drops below that of the second outlet chamber.

4. A valve as claimed in claim 2 wherein the anti-cavitation valve means is formed by an axial bore in the second valve member having spaced radial connections through the valve member side wall and valve means in said axial bore between said spaced radial connections movable in response to pressure differential between said chambers to permit flow from the second outlet to the second inlet chamber when the pressure in said second inlet chamber drops below that of the second outlet chamber.

5. A valve as claimed in claim 1 having relief check valve means connecting said second inlet and second outlet chambers.

6. A valve as claimed in claim 5 wherein the check relief valve comprises a third bore connecting said second inlet and second outlet chambers and resilient biased valve means in the third bore normally closing said bore and adapted to open when the pressure in the second outlet chamber exceeds a predetermined value.

7. A valve as claimed in claim 5 wherein the relief check valve means comprises an axial bore in the second valve member having spaced radial connections through the valve member side wall and resilient biased valve means in said axial bore between said spaced radial passages adapted to open when the pressure in said second outlet chamber exceeds a predetermined value.

8. A valve as claimed in claim 1 wherein the housing is in two parts, the second bore, second inlet and second outlet chambers and work port being formed in a second housing part removably attached to the first housing part.

9. A work port pressure compensator valve adapted to be removably attached to a directional control valve having an inlet chamber, a work chamber and an outlet chamber, the compensator comprising a housing having a compensator inlet chamber for connection to the work chamber of the directional control valve, a compensator outlet chamber spaced from said compensator inlet chamber, a work port connected to said compensator outlet chamber, a bore connecting said compensator inlet and outlet chambers, a compensator valve member movable in said bore and having an annular groove intermediate its ends, resilient biasing means urging said compensator valve member toward the compensator inlet chamber to a first position in which the compensator inlet chamber and compensator outlet chamber are in communication through the anular groove, a first signal passage connecting the compensator inlet chamber to the bore whereby fluid pressure in the compensator inlet chamber acts on one end of the compensator valve member to urge the compensator valve member toward said first position, and a second signal passage for connection with a passageway connected to the inlet chamber of the directional control valve the second signal passage being connected to said bore at the other end of the compensator valve member whereby when the compensator valve is attached to the directional control valve pressure fluid in the inlet chamber of the directional control valve will act on the end of the compensator valve member to urge the compensator valve member toward the compensator outlet chamber to reduce the flow of fluid through the groove in the compensator valve member whereby said compensator valve member will be moved in the bore in response to pressure differential between the inlet chamber of the directional control valve and the compensator inlet chamber to maintain a substantially constant pressure at the compensator work port.

10. A compensator valve as claimed in claim 9 having anti-cavitation valve means connecting said compensator inlet and outlet chambers.

11. A compensator valve as claimed in claim 10 wherein the anti-cavitation valve means comprises a second bore connecting said compensator inlet and outlet chambers and valve means in said second bore movable in response to pressure differential between said chambers to permit flow from said compensator outlet to said compensator inlet chamber when the pressure in the compensator inlet chamber drops below that of the compensator outlet chamber.

12. A compensator valve as claimed in claim 10 wherein the anti-cavitation valve means comprises an axial bore in the compensator valve member having spaced radial connections through the valve member side wall and valve means in said axial bore between said spaced radial connections movable in response to pressure differential between said chambers to permit flow from the compensator outlet to the compensator inlet chamber when the pressure in said compensator inlet chamber drops below that of the compensator outlet chamber.

13. A compensator valve as claimed in claim 9 having relief check valve means connecting said compensator inlet and compensator outlet chambers.

14. A compensator valve as claimed in claim 13 wherein the check relief valve is formed by a second bore connecting said comprensator inlet and compensator outlet chambers and resilient biased valve means in the second bore normally closing said bore and adapted to open when the pressure in the compensator outlet chamber exceeds a predetermined value.

15. A compensator valve as claimed in claim 13 wherein the relief check valve means is formed by an axial bore in the compensator valve member having spaced radial connections through the valve member side wall and resilient biased valve means in said axial bore between said spaced radial passages adapted to open when the pressure in said compensator outlet chamber exceeds a predetermined value.

16. A compensator valve substantially as herein described with reference to Figure 1, Figure 2 or Figure 3 of the accompanying drawings.

17. A compensated work port fluid valve substantially as herein described with reference to Figure 1, Figure 2 or Figure 3 of the accompanying drawings.

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**Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1978.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.**

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

Fig. 1.

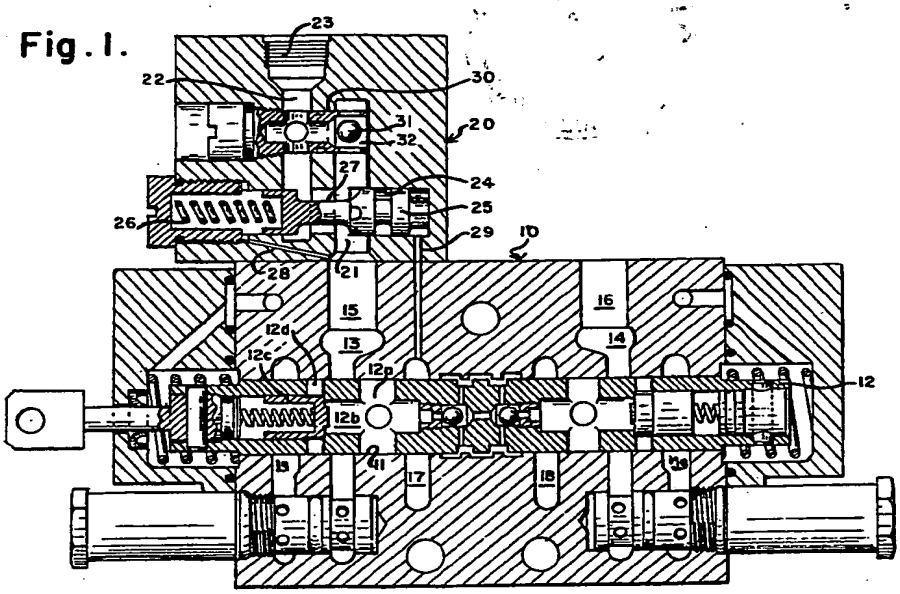

Fig. 2.

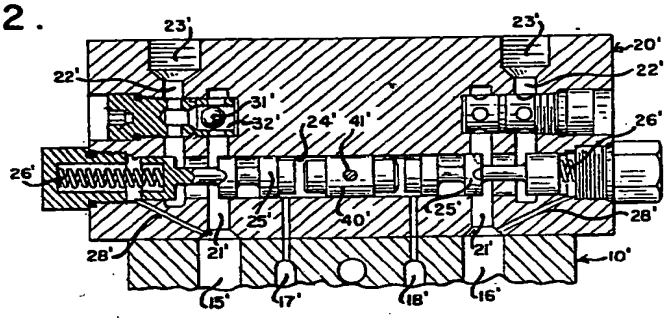

Fig. 3.